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QUALIFICATION TESTING OF THE BDU-12/B PRACTICE BOMB

Mahlon E. Traylor, Jr.

AIR FORCE SPECIAL WEAPONS CENTER
Air Force Systems Command
Kirtland Air Force Base
New Mexico

TECHNICAL REPORT NO. AFSWC-TR-68-19

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FOREWORD

This report was prepared under Project 057085, Program Element 6.44.15.03.4, by the Physical Engineering Branch of the Systems Engineering Division, Directorate of Test and Engineering, Air Force Special Weapons Center. Testing was performed at the request of the Air Force Weapons Laboratory (WLDM).

All actual testing was accomplished from 6 May through 12 June 1968. The report was submitted in July 1968 by the Air Force Special Weapons Center Test Director, Mr. Mahlon E. Traylor, Jr. (SWTEE).

Information in this report is embargoed under the Department of State ITIARs. This report may be released to foreign governments by departments or agencies of the U.S. Government subject to approval of AFSWC (SWTEE), Kirtland AFB, New Mexico, 87117.

This technical report has been reviewed and is approved.

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ABSTRACT

(Distribution Limitation Statement No. 2)

Vibration, shock, and static tests were performed for the purpose of upgrading the BDU-12/B to a supersonic air drop capability. Only one of the four units tested was capable of withstanding the predicted parachute opening forces, and that was with a negligible margin of safety. A potential, though not serious, fatigue characteristic was discovered in the tail mounting hardware. The BDU-12/B cannot be qualified for supersonic release.

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SECTION I

TEST ITEM

The BDU-12/B is a practice bomb designed for release from a fighter-bomber. The unit weighs approximately 500 pounds, has an overall length of 10 feet, and has a diameter of 14 inches. Upon release from its delivery aircraft, a drogue parachute is deployed to slow its descent.

SECTION II

TEST PROCEDURE

Past experience has shown that structural components fabricated of aluminum alloys may have their required strength characteristics degraded to an unacceptable level by exposure to temperatures associated with supersonic flight. Consequently, prior to any testing, the front part of the tail fins of BDU-12/B, SN 5227, were exposed to a temperature of 412°F for 20 minutes. The rest of the unit was placed in a 300°F environment and soaked for 20 minutes. See figures 1 and 2.

The required shock test is specified in method 516, Procedure 1 of MIL-STD-810A. This requirement is a slope-front sawtooth input of 20-g magnitude and a duration of 10 ms. This input is applied three times, first in one direction and then in the other, along the three mutually perpendicular axes for a total of 18 shocks. The large shock test machine at the Kirtland AFB facility is a home-built steel frame which is dropped onto a lead pig. The test item is mounted to a simulated bomb rack which, in turn, is affixed to the shock tester as shown in figure 3.

Method 514 of MIL-STD-810A, to which this unit was tested in vibration, calls for a resonant search to 2,000 Hz and then dwells at detected resonances. This is conducted along each of the three mutually perpendicular axes. A Ling, Model 249, hydraulic shaker and a large slip table are used at this facility for vibration testing. Figure 4 shows a typical test setup where the shaker is driving the slip plate.

The first of the static test requirements was to apply a 120,000-pound parachute drag force to the shroud line retainer ring. The method by which this load is applied is shown in figure 5. The unit, with fins removed, can be seen at the extreme left side of the illustration. The large steel rod inserted through the tail cone pulls on the shroud lines. The other end of the rod is acted on by a hydraulic cylinder. This cylinder, in turn, is controlled by a technician at a hydraulic control console. Force application can be read as a function of hydraulic pressure from a gage in the line. Both the unit and the hydraulic cylinder are firmly mounted between the two drilled channels shown in the picture.

SECTION III

TEST RESULTS

As explained in section II, the shock test equipment was quite crude. Each shock input was only one-half the specified 10 ms. Required g levels, however, were easily obtained. After the 18 shock-pulse inputs had been imposed, the unit was visually inspected. No evidence of any failure could be detected. Figure 8 is the record of a typical shock pulse as seen by the unit.

Vibration testing was successfully accomplished. The Z (vertical) axis vibration requirements were performed first. With the monitor pickup on the tail cone, distinct resonances were recorded at 51, 98, 172, and 492 Hz. The X (longitudinal) shake revealed resonances at 75 and 350 Hz. The Y (lateral) axis test was attempted but not accomplished. Figure 4 shows how far off the centerline of the slip plate the center of gravity of the unit is located. This poor confluence rendered the driving mechanism dynamically unstable. The remainder of Y axis time was evenly divided between the X and Z axes resonances.

All during the vibration test series, the screws holding the forward lug nut plate kept loosening. This would be of little consequence during a mission as long as the sway brace torque remained sufficient to keep the lug stressed. The only other discrepancy was the rupture of two of the tail fin lug screws. Figure 9 shows where the head has fatigued off one of these screws. Figure 9 also illustrates the position of the monitor pickup.

The first static pull on the parachute shroud lines of SN 5227 reached only 91,056 of the specified 120,000 pounds before failure. The mode of failure can be seen in figure 10. It can be seen that the forward casing pulled apart just forward of the retaining ring. The broken hardware in the center of the picture does not represent a failure. It is merely the result of impact on the steel pull rod after the case had failed.

This same forward case was the one used in the lug tests which were passed successfully with no visible permanent deformation to either lugs or case. The tail cone, on the other hand, was so badly bent because of impact that it would no longer match with its tail fins.

The tail fin static test was conducted on SN 0935. Figure 11 is a plot of the results showing that the fins sustained the applied loads satisfactorily. A preload of 20 percent was applied to eliminate possible extraneous effects of nonlinearity in the test setup. The left fin returned to within 0.006 inch of its initial 20 percent deflection and the right one to within 0.011 inch. Whether these slight residuals were in the tail, test setup, or both is undetermined. For all practical purposes it is considered that the elastic return was linear.

This same unit, as yet undamaged, was then used to repeat the parachute shroud line static pull test. It broke in the same manner as SN 5227 but at 77,216 pounds. In an attempt to obtain some sort of statistical validity to these ruptures, two more units were subjected to the parachute pull test. SN 5230 broke at a total pull of 82,499 pounds and SN 1369 broke at 95,098 pounds, both in a manner identical to the first two.

Figure 1. Tail Fin Heat Exposure

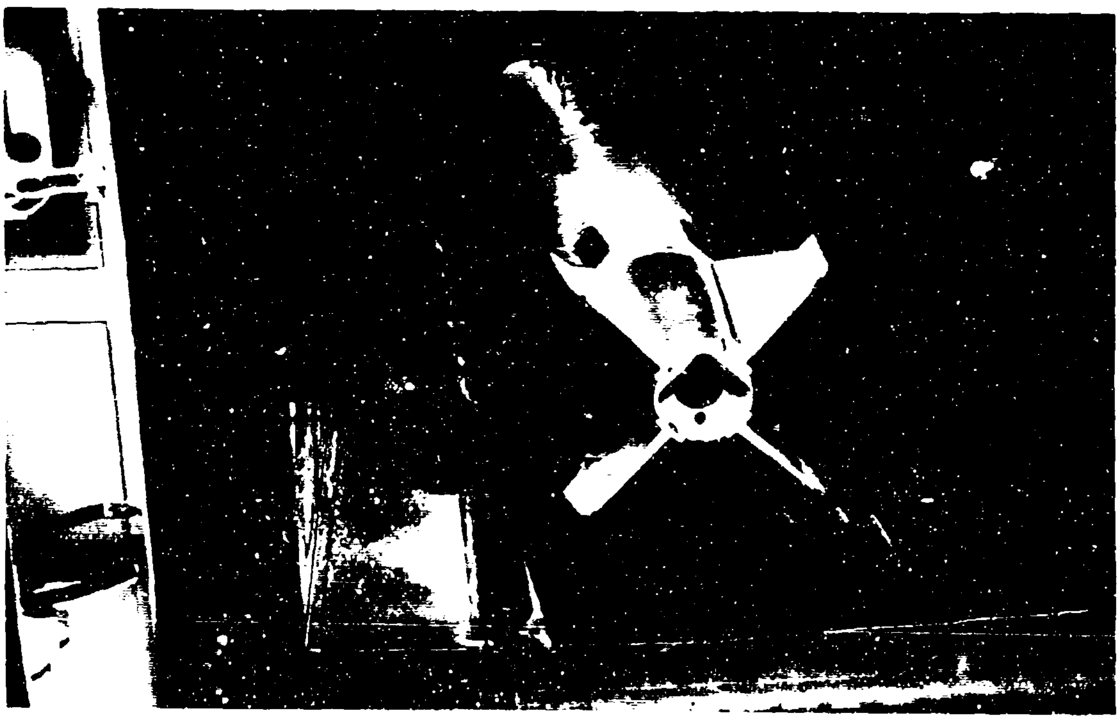

Figure 2. BDU Heat Exposure

Figure 3. Typical Shock Test Setup

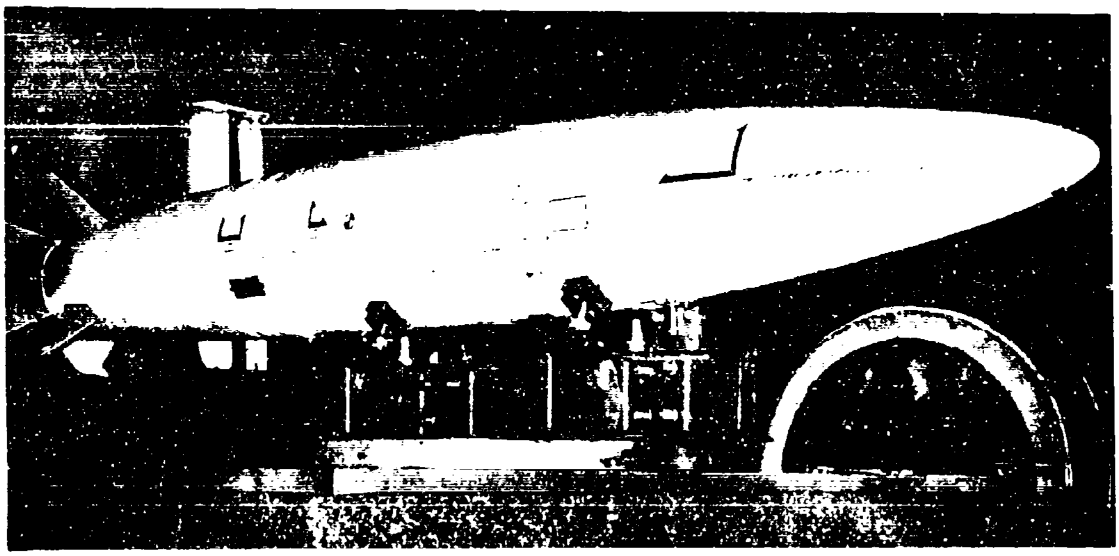

Figure 4. Typical Vibration Setup

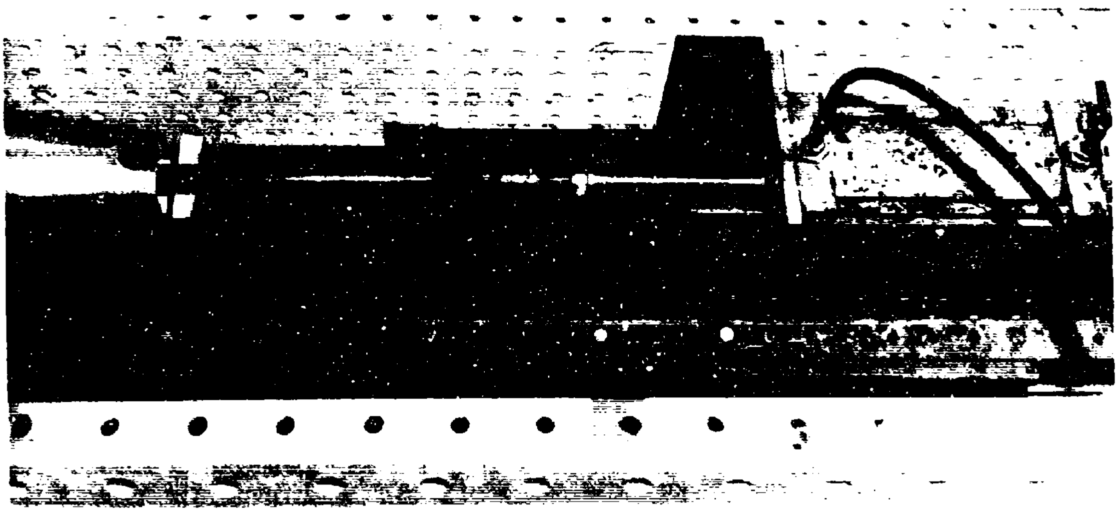

Figure 5. Parachute Drag Test Setup

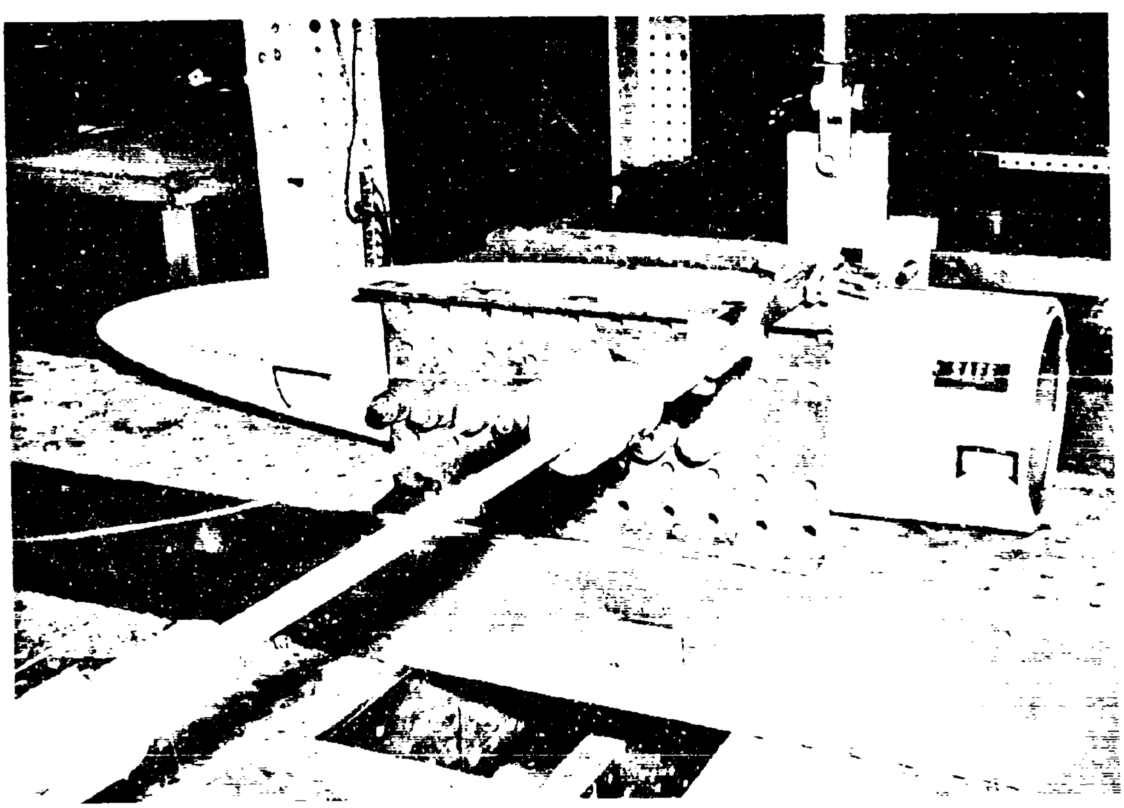

Figure 6. Triaxial Lug Loading

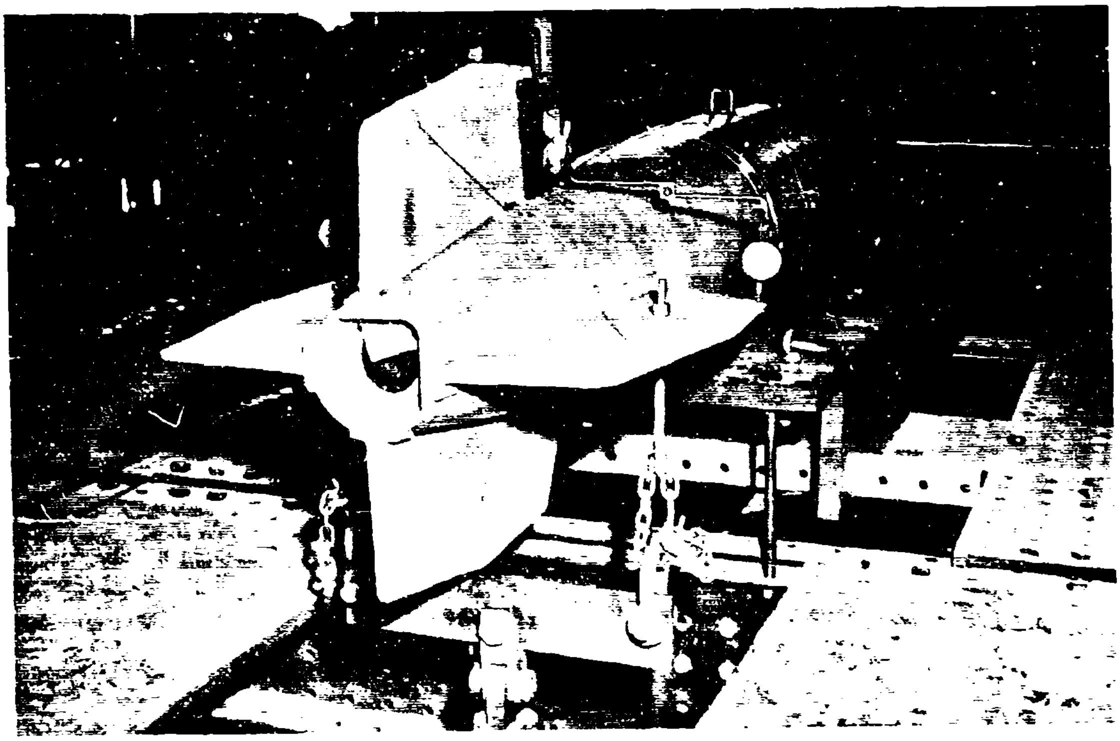

Figure 7. Tail Fin Test Setup

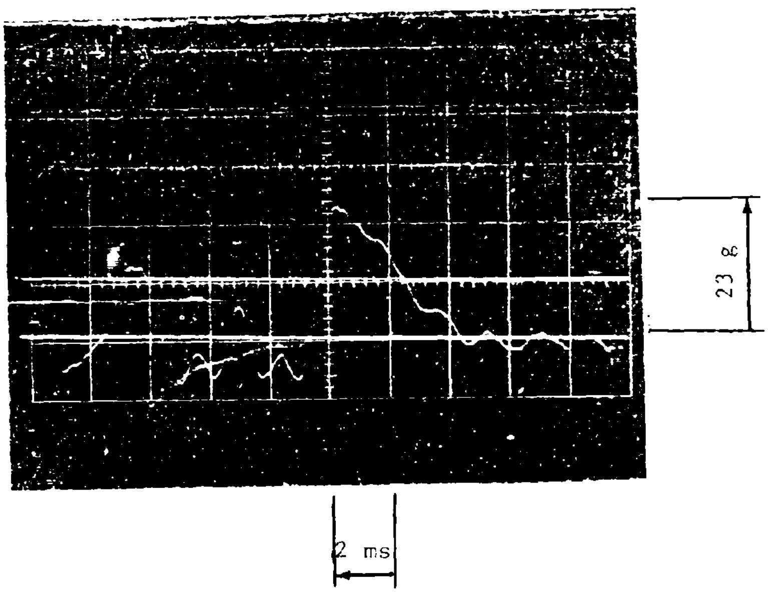

Figure 8. Typical Shock Test Record

Figure 9. BDU-12/B Tail Cone

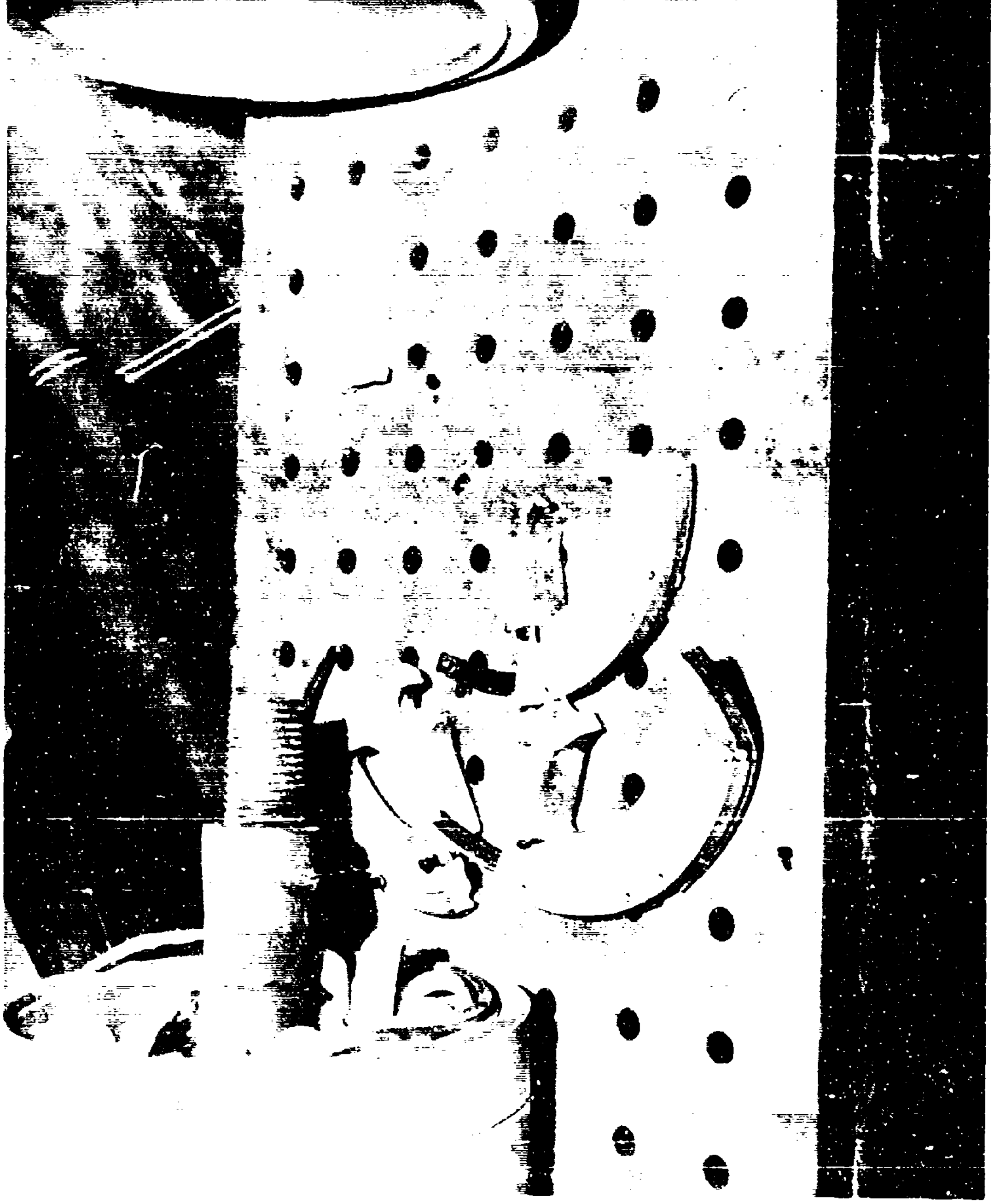

Figure 10. Static Test Failure

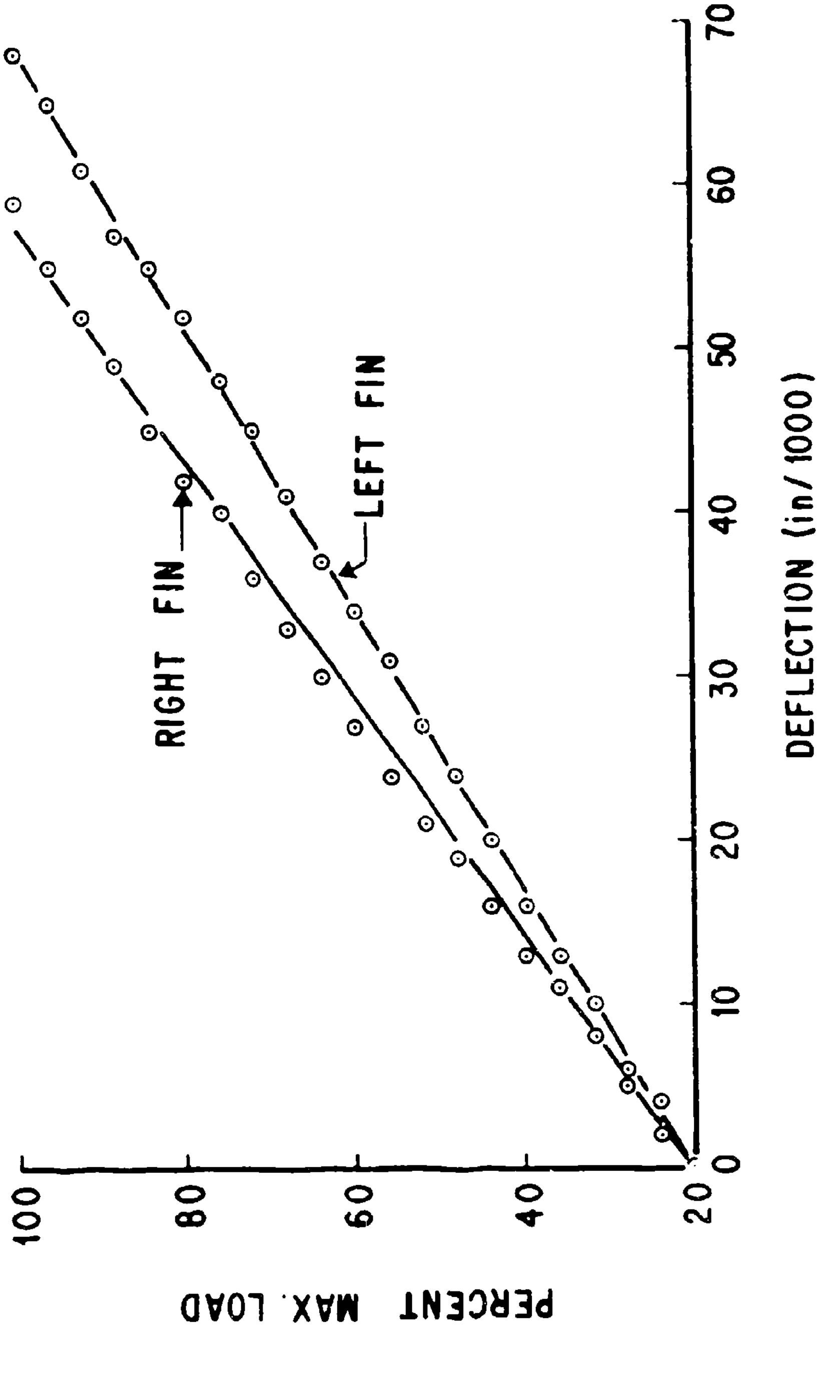

Figure 11. Tail Fin Test

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13. ABSTRACT

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13 March 1969

ADDENDUM

AFSWC-TR-68-19 QUALIFICATION TESTING OF THE BDU-12/B PRACTICE BOMB, October 1968 (UNCLASSIFIED)

Page iii, add: The Air Force Weapons Laboratory has furnished information to the effect that "successful operation of the BDU-12/B was unquestionably proven by 15 drops at Mach 1.2." The original specifications furnished by AFWL, to which the BDU-12/B was tested, were apparently too severe.

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24 February 1969

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